Why is Palmitic Acid of Interest to Dairy Producers.

What is the possibility of a Canadian source ?

David Christensen and Bernard Laarveld

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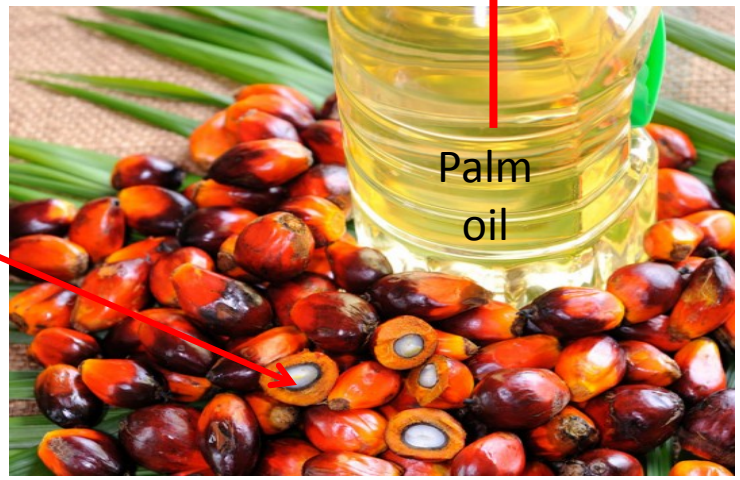
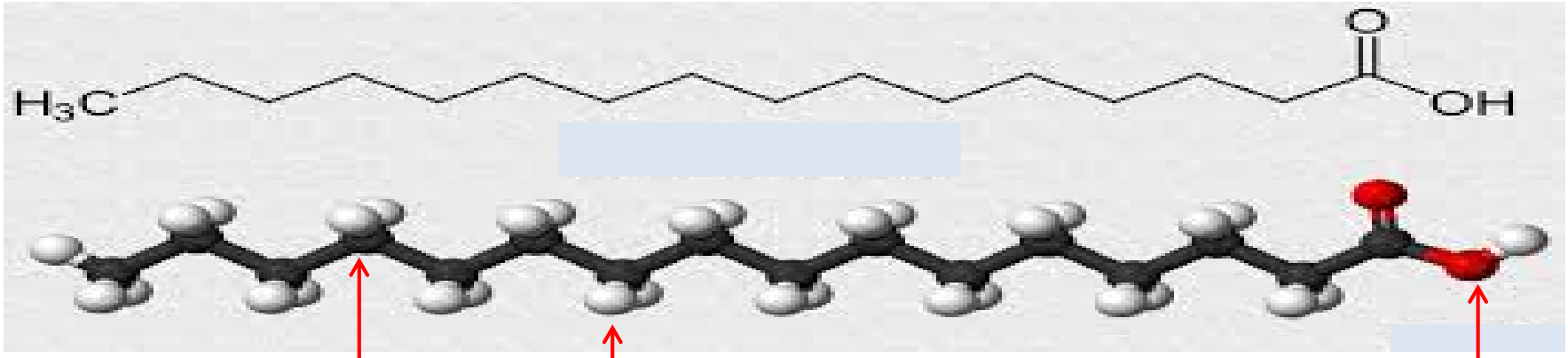


Palmitic acid is an 16 Carbon Saturated Fatty Acid



Carbon Hydrogen Oxygen

$$CH_3(CH_2)_{13}CH_2\overset{O}{\overset{\|}{C}}OH$$

Plant Sources of Palmitic Acid

	Plant oil Fat and Fatty Acid Composition (% of fatty acids)					
Source	Lipid	Palmitic	Stearic	Oleic	Linoleic	Linolenic
	%	C16:0	C18:0	C18:1	C18:2	C18:3
Palm	35	42	4	38	9	2
Flax	40	5.2	3.4	18	15	58
Soybean	20	9	5	45	37	3
Canola	40	4	2	55	26	10
Cottonseed	20	20	3	24	42	2
Sunflower	40	7	5	19	66	1
NuSun (Sunflower)	40	4	3	70	23	0.1
CAS-12 Spain	40?	32.1	6.4	45	11.4	0.5
Butter	82	26	11	28	2	0.5
Beef Tallow	80	27	7	48	2	0.1

Basic Description of Palmitic and Oleic Acids

Oleic is the main fatty acid in canola oil

Characteristics of Palmitic and Oleic acids		
Characteristic	Palmitic	Oleic
Chemistry	Saturated	One unsaturate
Structure	C16:0	C18:1
Melting point °C	62.9	16.3
Solubility in water	0.50%	Nil
Gross energy, Mg/kg	9.30	9.30

Uses of Palmitic Acid

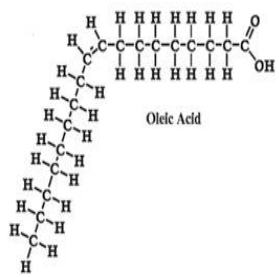
- Soap manufacture
- Cosmetics
- Improve processed food texture
- As a drug carrier
- Rumen protect nutrients (Choline)
- Fed to increase milk fat yield (%)
- Medical Use
  - Treat schizophrenia
  - To increase penis size

Palmitic Acid and the Dairy Cow

- Solid in the Rumen, temp of ~ 39 C, melts at 63 C
- Not soluble in rumen fluid, maybe 0.5%
- Not toxic, 6 kg in one feeding could kill half of the cows (LD_{50}).
- May be slightly irritating to skin and eye. Keep away from contact lenses.
- Approximately 35% of Palmitic acid eaten is transferred to milk, the remainder is used for energy or stored as body fat.

Palmitic is Different From Oleic Acid (18 Carbon) in the Rumen

- If the rumen pH is 7.0 (neutral), not acidic, there are equal proportions of H^+ and OH^- .
- As the rumen pH becomes acidic, there are a higher proportion of H^+.
- These H^+ molecules are looking for a home and attach to unsaturated fatty acids such as oleic acid.



In oleic acid there is room for two H on the omega-9 carbon. If they attach there the process is called biohydrogenation. The product is stearic acid.

Palmitic acid is fully saturated and not hydrogenated or altered in the rumen.

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http://dx.doi.org/10.3168/jds.2013-6680

Palmitic acid increased yields of milk and milk fat and nutrient digestibility across production level of lactating cows

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Palmitic Acid Trial (Lock and Allen, 2013)		
2% of TMR DM	Control	Palmitic
TMR Intake, kg DM	27.8	27.8
Milk, kg/day	44.9	46.0
Fat, %	**3.29**	**3.40**
Fat, kg/day	**1.45**	**1.53**
Protein, %	3.11	3.09
Protein, kg/day	1.38	1.41
SCC, '000	36.5	43.6
Milk, MUN, mg/dl	15.0	14.8
Body weight, kg	722	723
BCS	2.99	2.93

Palmitic Acid Transfer to milk ,%		
Fatty Acid	**Control**	**Palmitic**
C16:0, Palmitic	**33.0**	**37.6**
C18:0, Stearic	8.77	7.77
C18:1, cis Oleic	17.1	16.4

University of Saskatchewan trial	
300 grams fed per cow as top dress	
	Milk recovery
Early to mid-lactation	**35.00%**
Late lactation cows	**38.80%**

Plant Breeding Methods to Produce a Canadian Palmitic Acid Oilseed

- **Selection of plants/seeds with high palmitic acid. Was used with rapeseed to produce canola.**
- **Exposure of seed to a mutagen that disrupts DNA in the seed. Grow the seed and hope to find a high palmitic strain. Spanish method for sunflower. Will they supply their genetics? Not a GMO method.**
- **Move high palmitic genes from oil palm or other sources to produce a high palmitic crop. Many new techniques. A GMO method**

Table 1. Fatty acid composition in mutant sunflower lines.

		Fatty acid composition, % of total					
Phenotype	Treatment	16:0	16:1	18:0	18:1	18:2	Reference
Common oil	—	8	—	4	35	53	—
High 16:0	γ-rays	25	4	4	11	56	Ivanov et al. 1988
	X-rays	30	8	1	10	50	Mancha et al. 1994
High 16:1	X-rays	30	8	1	10	50	Mancha et al. 1994
High 18:0	Sodium azide	5	—	14	35	46	Mancha et al. 1994
High 18:1	DMS	4	—	3	79	14	Soldatov 1976
High 18:2	EMS, X-rays	5	—	3	12	80	Schmidt et al. 1990

Research from Novi Sad, Serbia.

Can. J. Physiol. Pharmacol. **86**: 215–221 (2008)

Enzymatic characterisation of high-palmitic acid sunflower (*Helianthus annuus* L.) mutants

Planta (1999) 207: 533–538

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Received: 11 July 1998 / Accepted: 10 October 1998

Table 1. Fatty acid composition of total lipids from seeds of mutant sunflower lines (HA-OL9, at 15 DAF. SD < 2.5%

	Fatty acid composition (mol %)[a]					
	16:0	16:1 Δ9	16:2 Δ9Δ12	18:0	18:1 Δ9	18:1 Δ11
RHA-274	8.0	0.2	–	7.1	51.9	0.3
CAS-5	31.5	4.4	0.7	2.8	12.7	3.6
HA-OL9	5.6	0.1	–	6.4	80.1	0.9
CAS-12	32.1	4.5	0.3	3.8	42.3	3.3

HELIA, **31**, Nr. 48, p.p. 55-60, (2008)
DOI: 10.2298/HEL0848055V
UDC 633.854.78:631.523

A NEW SUNFLOWER MUTANT WITH INCREASED LEVELS OF PALMITIC ACID IN SEED OIL

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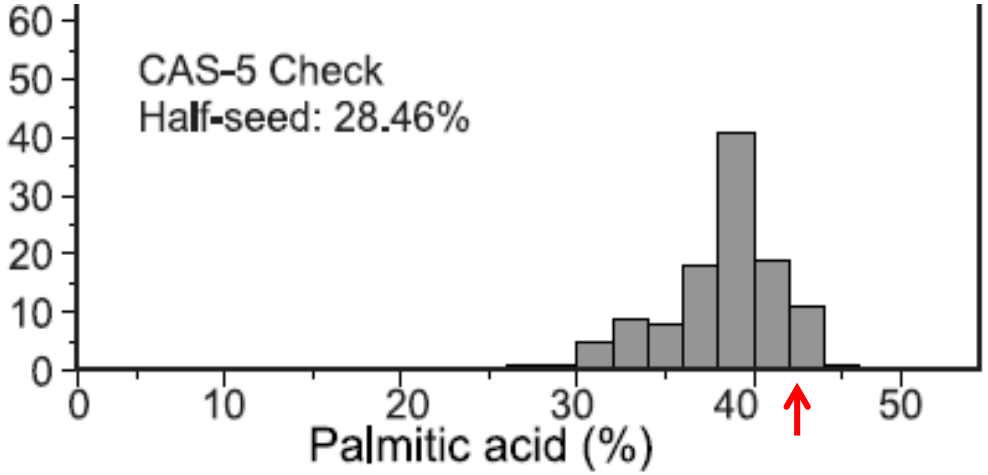

Figure 3: Palmitic acid content of two $M_{3:4}$ families derived from M_3 seeds with high palmitic acid content, and the high palmitic acid mutant CAS-5 grown as a check in the same environment.

Canadian Intellectual Property Office

Home > Canadian Patent Database > Patent Summary

Canadian Patents Database / Patent 2710364 Summary

- ► Third-party information liability
- ► Claims and Abstract availability

(12) Patent Application: (11) CA 2710364

(54) English Title: SUNFLOWER OIL WITH HIGH HEAT STABILITY

(54) French Title: HUILE DE TOURNESOL A THERMOSTABILITE ELEVEE

Bibliographic Data Abstracts Claims Representative Drawing Admin Status Documents

(51) International Patent Classification (IPC):

A23D 9/00 (2006.01)
A01H 5/00 (2006.01)
A01H 5/10 (2006.01)
C10L 1/02 (2006.01)

2009 application update. 15% to 45% Palmitic plus Stearic. Up to 75% oleic and high tocopherol (Vit E) level.

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PEREZ VICH, BEGONA (Spain)

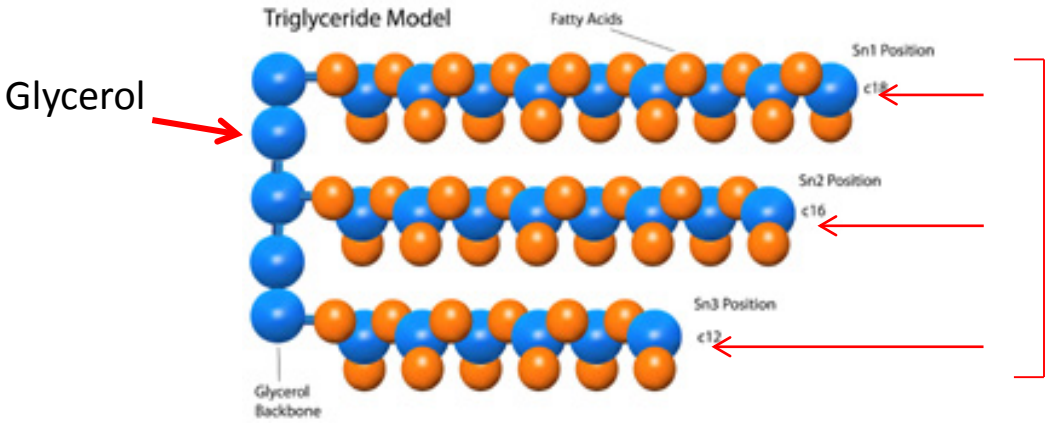
(73) Owners (Country):

CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS (Spain)

Processing Palm Oil to Produce Palmitic acid

Palm olein is the liquid fraction obtained from fractionation of palm oil. The fractionation process involves a **physical process of cooling the oil under controlled conditions to low temperatures, followed by filtration of the crystals through a membrane press**. The liquid olein and solid stearin are products of fractionation, and they are the major products exported.

Separation of Palmitic acid would require hydrolysis before cold separation of Palmitic acid.



Three fatty acids

Sunflower seed processing method would have to be developed, unless direct feeding of sunflower seeds to dairy cows is proven effective.

How Big is the Canadian Dairy Market for a Palmitic Acid Product?

- 29,000 cows in Saskatchewan. 30% fed 0.3 kg Palmitic product per cow daily, 2.61 tonnes per day, 952 tonnes per year. Market value at $2,000 per tonne = $2 million/yr.
- Canadian market. 950,000 cows, 30% market penetration and 0.3 kg per cow daily. 85.5 T per day. 31,200 T/yr x $2,000 = $62.4 million/yr.
- Cost of research? Value of meal, other fats?
- Economic multiplier effect? Export opportunity?
- World palm oil production is 50 million tonnes per year. Oil yield per acre is 10 times Canola.

Is Palmitic Acid a Health Concern?

- **Not for dairy cows.**
- **Will raise LDL (bad) cholesterol, but not HDL (good) cholesterol in people.**
- **Has not been shown to impair circulatory health, but could be a factor in lower bowel cancer. Mainly with processed meats.**
- **Reduces butter softness by about 10% if cows fed palmitic acid.**
- **Milk palmitic acid is increased by 3% or 0.20 g in a liter of milk. This is about 1.2 kcal in a diet of 2500 kcal/day.**

Now What??

- **Acquire and evaluate existing high palmitic Sunflower strains from Spain or?**
  - **Feed a new high palmitic Sunflower variety directly or use an existing Biodiesel company to extract and produce an 88% palmitic product?**
- **Encourage Canadian Plant breeders to develop a new high Palmitic Sunflower, Canola or Flax by mutagenic or GMO methods? Long term, strategic and high cost.**
- **Market survey to estimate market potential and cost of research. Time line?**

Benefit to the Canadian Economy of a new high Palmitic Oilseed?
How to Initiate a Plan?
The Role of Dairy Producers?

The team required

- Economist
- Plant geneticist
- Agronomists
- Process Engineer
- Nutritionist
- Feed industry
- Dairy producers

Implementation of a Plan

- Would require Provincial initiative
- Call for proposals by a consortium
- Fund $2 to 3 million over 5 years or more